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Original Research

A Phenomenographic Research Study of Students' Conceptions of Mobile Learning: An Example From Higher Education

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Abstract

This article aims to identify different ways of using mobile devices in students' learning in higher education. This qualitative research presents the findings from a phenomenographic research of students' conceptions of mobile learning (m-learning) in higher education. A cohort of 16 students from four universities of Bangladesh took part in semi-structured interviews to explore their in-depth understandings and experiences of m-learning. The findings indicate that university students perceived five qualitatively different ways of using mobile devices in their learning: a medium for communication; a medium for management of learning materials; a tool for effective learning; a means for collaborative learning; and a means for development of new ideas. The findings of this research demonstrate students' pedagogical understanding of using mobile devices in higher education. The outcomes of this research could play a crucial role in informing students on how they can use their mobile devices for learning purposes and providing educators with empirical evidence on students' pedagogical practices of using mobile devices in other developing and more developed countries in the world.

Keywords

phenomenography, pedagogical issues, mobile learning (m-learning), conceptions, students learning

Introduction

Increasing evidence shows that mobile devices such as mobile smartphones, tablets, and portable multimedia players (PMPs) are increasingly used in higher education around the world (Alrasheedi & Capretz, 2018; Churchill, Fox, & King, 2016). Therefore, an important area for educational research has emerged due to the widening use of mobile devices in higher education (Al-Adwan, Al-Adwan, & Berger, 2018; Oyelere, Suhonen, Wajiga, & Sutinen, 2018). Recent studies have provided evidence about the positive effects of using mobile devices in student learning. For instance, accessing learning management systems (LMS) to read and download learning materials, share ideas among peers, follow the latest announcements, and communicate with peers and teachers has become a common practices among university students (Al-Adwan et al., 2018; Joo, Kim, & Kim, 2016). Mobile devices, therefore, have become a very useful medium due to their dynamic uses within mainstream practices of university education in both developed and less developed countries around the globe. Considering their importance, countries have been making efforts to finalize suitable pedagogical techniques to incorporate mobile devices in student learning. Although prior literature shows that mobile learning influences pedagogical practice, little empirical research in higher education has confirmed pedagogical strategies that support learning (Churchill et al., 2016; Mireilla Bikanga, 2018; Shohel & Power, 2010). For instance, student's way of using mobile devices in higher education may have supportive or destructive influences on teachers' teaching practice. This claim is further supported by Daughtery and Berge (2017) who reported that "Although the use of mobile devices has increased dramatically in education sectors, nonetheless, there has not been a corresponding increase in mlearning scholarship regarding pedagogical approaches" (p. 111). Therefore, it is useful to conduct in-depth research toward finalizing different learning strategies while using mobile devices in higher education.

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Identifying effective ways to incorporate mobile devices in student learning is essential as research has shown that mobile device use can hinder learning. Sometimes, students may use their devices for personal conversations (Balakrishnan & Gan, 2016), to play mobile games (Scornavacca, Huff, & Marshall, 2009), or to provide opportunity for students disengaged (Heflin, Shewmaker, & Nguyen, 2017). Apart from these, Bartholomew and Reeve (2018) reported additional challenges of using mobile devices in students' learning such as potential for harassment, cheating, or invading students' privacy. As few studies somehow report negatively on using mobile devices in learning, in-depth investigation is required to clear up this uncertainty with empirical evidence.

In addition, this research area is only at the beginning of an understanding of the complexities of students' conceptualization of mobile learning (m-learning) in higher education. It is useful to find out different ways of using mobile devices in university education through second-order perspectives (students' conceptions of m-learning), which is either scanty or nonexistent in the literature to date. Hsieh and Tsai (2017) likewise claimed that primary users' (i.e., teachers and students) conceptions of mobile learning are limited. To fill this void, they investigated high school teachers' conceptions of mobile learning and identified six teachers' conceptions toward mobile learning. Prior literature reported that teachers' conceptions has impacted on students' learning in higher education (Prosser & Trigwell, 1999). Students' conceptions of mobile learning in higher education are therefore imperative to investigate to provide useful insights for linking teachers' conceptions. In a global perspective, the knowledge about students' learning via mobile devices is limited, which is also supported by Pimmer, Mateescu, and Gröhbiel (2016) "after more than 20 years of mobile learning research, there is still relatively little systematic knowledge available, especially regarding the use of mobile technology in different educational designs and with associated educational effects in higher education settings" (p. 492). This research provides further empirical evidence by analyzing students' conceptions of m-learning that are linked to different pedagogical strategies of using mobile devices in classroom teaching and learning. Therefore, the aim of this research is to discern university students' experiences in using mobile devices in their learning. This aim guides the following broad research question:

Research Question 1: What are the qualitatively different ways university students understand m-learning in higher education?

The Bangladeshi Context and Need for Mobile Learning

Bangladesh, bordered by India and Myanmar, has a population of approximately 161 million people, divided into the eight divisions of Dhaka, Chittagong, Sylhet, Rangpur, Rajshahi, Khulna, Barisal, and Mymensingh. In Bangladesh, primary education is compulsory and free. The Government of Bangladesh (GoB) considers education a fundamental right of the population and, thereafter, expects economic development and growth of the country through educated people. Due to the rapid advancement of technology in the socioeconomic development of many countries around the globe, the GoB has refocused their attention on integrating technology in education sectors. Therefore, the GoB has already introduced several initiatives to integrate different forms of Information and Communication Technology (ICT) (the use of mobile devices for teaching and learning is one of the emerging areas of ICT) in both higher education and secondary education.

Furthermore, the GoB realizes that ICT-related skills can enhance the eradication of poverty in society, so they are taking steps to integrate ICT in education. The GoB, in their vision-2021, adopts National ICT Policy-2009 and National Education Policy 2010 as a part of its developmental aspirations as it moves forward to become Digital Bangladesh. To achieve these policies, the GoB has already undertaken many initiatives. For instance, it converted paper-based books into electronic version (www.ebook.gov.bd), formed a2i (access to information) aiming to incorporate technology in all sectors of Bangladesh (www.a2i.pmo.gov.bd).

The GoB and other stakeholders realized that mobile devices as educational tools have the potential to contribute to empowering a large population with minimal effort and cost. In addition, mobile phones in Bangladesh have many other powerful advantages over other ICT-supported educational tools such as computers. To this point, Buckner and Kim (2012) emphasized that mobile phones require substantially less infrastructure and electricity and are capable of reaching even the most isolated learners. In the case of Bangladesh, 98% of the population use a mobile network (The Global Economy, 2016). Thus, mobile devices are the easiest way to capture the huge population in Bangladesh particularly, and the countries which have similar infrastructure in the Globe generally. Therefore, to make the above-stated vision a success, the GoB, and other stakeholders (policymakers, university authorities, etc.), could recognize potential benefits of incorporating mobile devices in student learning. It is worth citing a few examples of m-learning initiatives in Bangladesh: the GoB and the Department for International Development of the United Kingdom's Government commenced a developmental project (2008-2017) aiming at equipping 25 million Bangladeshi students with the skills to communicate in English through using mobile devices (Shohel & Power, 2010). As mobile phones can store large amounts of learning materials, Bangladesh Open University (BOU) designed mobile-set compatible memory cards that contain e-books and digital materials for the learners. BOU uploaded nearly 400 textbooks (e-books) for almost all academic programs they offer (see Islam, 2018).

The GoB and other stakeholders relocate their interests on promoting m-learning in Bangladesh for three main reasons. First, mobile devices, particularly mobile phones, are the most accepted ICT in Bangladesh due to their rapid adoption this decade (Valk, Rashid, & Elder, 2010). It has been reported that half of the population in Bangladesh live on less than a dollar a day (Begum, 2011); however, mobile phone subscriptions had increased to 128.94 million by July 2016 (Bangladesh Telecommunication Regulatory Commission, 2016). More importantly, the number of mobile device users among university students has increased exponentially. For example, current evidence shows that the majority of university students in Bangladesh are using mobile phones and/or other mobile devices due to reduction of cost and increased availability that fits with their current socioeconomic status. Second, due to financial constraints, not every student is able to afford both a mobile phone and a personal computer. Therefore, mobile phones are affordable for university students, who generally use them to communicate with teachers, peers, and parents and for recreational purposes, but less often for learning (Begum, 2011). Third, the popularity of using the Internet through mobile devices among university students in Bangladesh has increased in the last few years due to increasing Internet speeds and cheaper Internet connections offered by mobile providers (Begum, 2011). Thus, it is convenient for university students to use different forms of mobile applications in their daily lives. All the above stated aspects, therefore, provide numerous opportunities to use mobile devices as a learning tool in Bangladeshi university education; however, mobile phones have not yet been widely integrated into everyday educational practices.

The higher education system of Bangladesh mostly emulates the Western education system in general and the British education system in particular. In Bangladesh, higher education, including the field of engineering, was established by the British to meet their colonial needs in 1879 (Chowdhury, Alam, Biswas, & Islam, 2008). Therefore, Islamic belief and culture is not the dominating force shaping Bangladeshi higher education. A few examples are worth citing in this regard, such as male and female students studying together. The students have the freedom to wear any clothing and are not restricted to the Islamic dress code, which results in trends similar to other Western universities in the world. Therefore, we do not observe any epistemology, either Islamic or secular, that forces the students to use mobile devices in their learning. In fact, they embrace mobile devices as typically as others across the globe.

We chose to conduct this research in Dhaka division, Bangladesh, which is the third most densely populated city in the world with 23,234 residents per square kilometer. It has been ranked second in the world in its active use of Facebook (Murad, 2017). The number of mobile phones and Internet subscribers is increasing dramatically in Dhaka, and Bangladesh in general (Islam, 2018). The use of mobile phones is common among university students in Dhaka. Therefore, we believe that the use of mobile phones in student learning in Dhaka division may have dramatic effects and that it is an optimal environment for this research.

Literature Review

Mobile Learning and Its Current Possibilities

With the rapid advancement of ICT, the ways in which learning materials are being delivered and learning takes place are a completely new landscape (Wagner, 2018). In the last few years, the trend of using ICT in education has included a new paradigm through m-learning, as mobile devices are becoming increasingly popular among students (Bartholomew et al., 2017). In this trend, Heflin et al. (2017) states that mobile learning provides educators with an opportunity to redesign teaching and learning. A large number of studies describe m-learning as a learning platform that is situated on mobile and wireless devices such as tablets, smartphones, and personal digital assistances (Putnik, 2016; Turner, 2016). These bodies of research made a distinction between personal computers (desktop and laptop) and mobile devices due to their distinct features of ubiquity and portability. In this research, we considered m-learning as a platform where student learning can continue through portable devices such as cell phones, smartphones, palmtops, tablets, and PMPs to remove geographical barriers and allow students to learn anywhere and anytime with or without Internet connectivity. This is suitable for accessing learning materials via the Internet as well as reading downloaded learning materials (Al-Adwan et al., 2018). Furthermore, Buckner and Kim (2012) reiterated, "Among the major advantages of mobile devices are that they require substantially less infrastructure and electricity and are capable of reaching even the most isolated audiences" (p. 179). Due to these features, students can access learning materials and supplement their education even in the most isolated and rural underserviced areas of the world. However, there are still instances where mobile networks are still unable to reach some individuals and communities.

Mobile devices have a variety of fascinating features such as SMS, voice mail, audio and video recorders, cameras with high-end output, games, and diverse apps. These features enable a range of multimedia materials—for instance, audio, video, graphics, learning platform through gaming, and integrated media—that offer diverse teaching and learning opportunities with new and innovative options for student–technology linkage in learning both inside and outside the classroom (Churchill et al., 2016; Wong & Looi, 2011). Recent research additionally reports that mobile devices and their emerging applications powered by cloud computing and social media support new forms of learning platforms for higher education that cannot be otherwise offered through conventional multimedia materials (e.g., Churchill et al., 2016; C. H. Lai, Yang, Chen, Ho, & Chan, 2007).

Studies have also reported several additional benefits of using mobile devices in higher education. For instance, one of the most significant advantages of using mobile devices is to provide student-centered teaching where student learning generally depends on their active involvement and teachers are generally seen as facilitators (Ekanayake & Wishart, 2014). Other research reported that m-learning implements collaborative learning where students share their ideas and views to clarify the concepts they are learning (Fu & Hwang, 2018). To clarify the use of mobile devices in higher education, Heflin et al. (2017) reiterated "In whatever ways they are employed, mobile devices and educational applications should not complicate the learning process, but facilitate mobile learners' learning" (p. 92). Thus, mobile devices provide a myriad of learning opportunities.

Conceptions of Learning in Different Contexts

A substantial number of interview-based studies have been conducted focusing on students' conceptions of learning in different countries that report students hold qualitatively different conceptions of learning in higher education (Marton, Watkins, & Tang, 1997; Säljö, 1979; Van Rossum & Schenk, 1984; Van Rossum & Taylor, 1987; Yang & Tsai, 2010). For example, in Sweden, Säljö (1979) evaluated students' conceptions of learning using a phenomenographic research approach and identified five categories of description: (a) the increase in the knowledge, (b) memorizing, (c) the acquisition of facts, (d) the abstraction of meaning, and (e) an interpretative process aimed at the understanding of reality. Thereafter, with the advent of phenomenography as the theoretical and methodological underpinning, a significant amount of research on students' conceptions of learning was carried out in the subsequent years. For instance, a series of interview-based studies investigated similar phenomena in the Netherlands such as Van Rossum and Schenk (1984), Van Rossum and Taylor (1987) and Marton, Beaty, and Dall'Alba (1993), and in the United Kingdom such as Morgan, Gibbs, and Taylor (1981) supported Säljö's (1979) five conceptions of learning. Later studies, however, identified one new category that could be added due to its nature of sophistication: (f) changing as a person (e.g., Marton et al., 1993). It is also evident that the categories have been arranged hierarchically, that is, the first three categories are viewed to be of low-level learning where the learners simply reproduce what they have been taught. In contrast, the latter three are considered to be higher level with a qualitative view of learning, in which the learners seek to gain deeper meaning and understanding of what they have been taught.

Gradually, the focus on students' conceptions of learning has shifted to diverse educational contexts such as cultural and disciplinary variations, levels of study, learning environment (space of learning), and other contextual factors. Marton et al. (1997) conducted a study in Asia and identified learning to be perceived as a combination of memorization and understanding. Therefore, it is clear that cultural diversity has influences on students' conceptions of learning. To this point, Tsai and Kuo (2007) reported that students' conceptions of learning in the United States focus more on cognitive (mental) processes, internal learner characteristics, externally existing bodies of knowledge, and social contexts, whereas students' conceptions of learning in China emphasize memorization, seeking knowledge, achieving an academically standard depth of knowledge, the combination of education and moral values, and contributions to society. In addition, Vermunt and Vermetten (2004) identify five categories of description of learning: construction of knowledge, intake of knowledge, using knowledge, stimulating education, and cooperative learning. Four categories of Vermunt and Vermetten (2004) support the prior literature of students' conceptions of learning except the category of *stimulating education*—which reports that educational settings have an influence on students learning. Prior research reported that student' conceptions of learning are contextually dependent (Eklund-Myrskog, 1998). Therefore, in recent years, studies have not only evaluated students' conceptions of learning in general contexts, but research has also focused on students' conceptions in different modes, such as learning through online peer assessment (Yang & Tsai, 2010), adult students' conceptions of learning through distance education (Makoe, Richardson, & Price, 2008), and online collaborative writing tasks and environments (Limbu & Markauskaite, 2015). These studies have identified different categories of description that are contextually dependent and provide useful knowledge and insights that contribute to improving student learning in higher education.

Overall, this review of prior literature on students' conceptions of learning in different contexts has shown that there has been very little research conducted both in developed and developing countries, including Bangladesh, which explores students' conceptions of m-learning. Prior literature reports that the major body of research on m-learning mainly focuses on finding the benefits and impacts of m-learning (Hahn & Bussell, 2012; Wang, Shen, Novak, & Pan, 2009), factors influencing students' mobile use in learning (Hu et al., 2016; Park, Nam, & Cha, 2012), and students' perceptions of using mobile devices (Kafyulilo, 2014; Putnik, 2016). However, research on students' conceptions of m-learning in higher education is limited. There is certainly a need for new research on students' conceptions of m-learning, particularly in Bangladeshi higher education. Therefore, this research attempts to fill those gaps using the phenomenographic perspective to investigate university students' conceptions of m-learning in higher education. Those experiences are fundamental in formulating pedagogical approaches that allow educators to provide adequate learning environment through mobile devices.

Methodology and Research Design

This research investigated university students' conceptions of mobile devices in their learning. Therefore, the phenomenographic research approach was adapted for identifying peoples' conceptions (Marton, 1986, 1994). The following subsections outline the detailed procedure involved in the phenomenographic research approach.

Phenomenography

Researchers using the phenomenographic approach hold certain assumptions in relation to the creation of knowledge. They conceptualize that knowledge is relational, that is, the nature of knowledge in a distinct context is not entirely independent. Rather, it is subjective and maintains a relationship with the subject of the study (students) and the investigated phenomenon (m-learning in Bangladeshi university) (Bowden, 2005; Svensson, 1997). Therefore, the creation of knowledge is discerned from the subjects' experience toward the phenomenon. The focus of this research approach is not to discern peoples' experiences of a particular phenomenon as such, rather it focuses on identifying variation in the ways of experiencing a phenomenon that could be presented in a limited number of qualitatively different categories (Marton & Booth, 1997). Thus, the aim of using phenomenography in this research was to develop a set of categories of description derived from the students' understanding regarding the use of mobile devices in their learning.

Each category of description reflects a distinct feature of the experience of the investigated phenomenon that is logically linked with one another and, at the same time, describes their similarities and dissimilarities (Bruce et al., 2004). Combining these categories together constitutes a structure known as the *outcome space* that describes the different ways and relationships through which a researcher interprets how a phenomenon is experienced at a cohort, group, or collective level (Åkerlind, 2012). Within the premise of this research, we explored students' conceptions of m-learning in university education and interviewees were asked to provide their reflections on using mobile devices in their learning. Therefore, we followed a phenomenographic strategy to determine sample size, collect data, and analyze data to discern final outcome space.

Participants

Purposive sampling technique was used in selecting the participants to ensure the required level of variation among the participants' experiences and, consequently, among their ways of perceiving a particular phenomenon. We followed three main principles to maximize the variations among the participants: (a) each selected student had some experience of using mobile device in his or her learning for at least 6 months so as to maximize the student's in-depth understanding of the phenomenon. However, the degree of experience among different respondents and the type of mobile devices used were not necessarily the same and were taken into account to achieve maximum variation in their experiences; (b) participants were recruited from different disciplines, levels of study (undergraduate and postgraduate), and genders (male and female) (Green, 2005); (c) participants were 16 students from four different Bangladeshi universities to maintain sufficient diversity as in phenomenography, and the recommended sample size is typically 15 to 20 (Trigwell, 2000). The basic characteristics of the participants are described in Table 1.

Data Collection

Interviews, which are considered one of the dominant data collection techniques in phenomenographic research, were used (Marton, 1986). Prior studies recommend that interviews provide the greatest potential to collect and to clarify data in phenomenographic research (Åkerlind, 2005; Bowden, 2000; Khan, 2014; Khan & Markauskaite, 2017). During this process (interviews), information could be clarified in ways that are not easy through other methods of data collection. In this research, therefore, a semi-structured interview schedule with a list of questions was constructed and each interview, lasting between 35 to 50 min, was conducted separately in public places, which were convenient for the interviewees to express their views freely and comfortably. Semi-structured interviews were used so that new ideas could be bought up during the interview depending on what the participant said. Consent was sought confirming the date, time, and place of the interview, following all the ethical standards required of this research.

During the interview process, questions were asked, and whenever necessary, follow-up prompts were used to ask for discerning participants' deeper awareness and experience about m-learning. The questions were mainly divided into two parts. The first part puts emphasis on the "what" questions, such as "What does m-learning mean to you?," whereas the second part emphasized the "how" questions including questions like "How do you use mobile devices in your learning?" (see Figure 1). Phenomenography is based on a second-order perspective, focusing on how phenomena are perceived by people, rather than on a first-order perspective, in which someone attempts to describe phenomena "as they are" (Marton, 1981). Consequently, this has influenced the way in which research questions are formulated, posing questions of "how" and "what," instead of "why". Follow-up questions were asked only when participants failed to provide their deeper understanding in response to the leading questions. A few examples of neutral follow-up questions were as follows: "Why do you think this that way?," "Could you explain more?," and "Could you provide one more example to clarify your explanation?." These follow-up questions helped the researchers to reveal participants'

Table 1. Summary of the Characteristics of the Participants.

Student ID	Level of study	Discipline	Experience with m-learning	Gender	English fluency
P1U1	Postgraduate	Computer Science	2 years	Male	Fluent
P2U1	Undergraduate	Electrical & Electronic	4 years	Male	Fluent
P3U1	Postgraduate	Computer Science	3 years	Male	Fluent
P4U2	Undergraduate	E&L (English & Literature)	4 years	Male	Fluent
P5U1	Undergraduate	Electrical & Electronic	3 years	Male	Fluent
P6U2	Undergraduate	E&L	5 years	Male	Fluent
P7U2	Undergraduate	Business	3 years	Female	Fluent
P8U3	Undergraduate	Law	3 years	Male	Fluent
P9U1	Undergraduate	Computer Science	3 years	Male	Fluent
P10U2	Undergraduate	E&L	2 years	Female	Fluent
P11U2	Undergraduate	Pharmacy	1 years	Male	Fluent
P12U1	Undergraduate	Mechanical engineering	3 years	Male	Fluent
P13U4	Undergraduate	Business	4 years	Male	Fluent
P14U2	Undergraduate	E&L	6 months	Male	Fluent
P15U1	Undergraduate	Computer Science	1 year	Male	Fluent
P16U4	Undergraduate	E&L	2 years	Male	Fluent
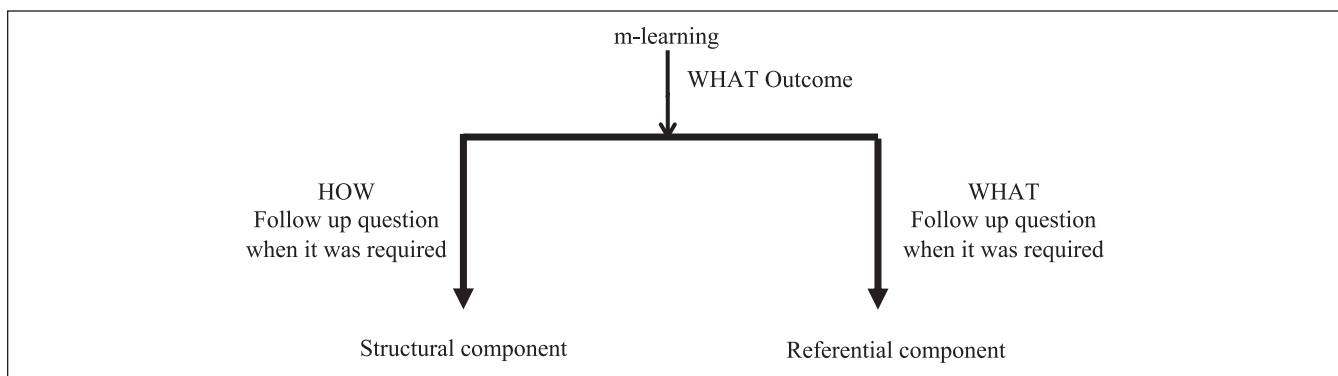
Figure 1. Structure of categories describing m-learning, adopted from Ellis, Goodyear, Prosser, and O'Hara (2006, p. 245).

in-depth understanding about mobile use. Each interview was recorded to avoid taking notes during the interview and to ensure accurate accounts of interviews were analyzed.

Analysis of the Data

The analysis of the data was conducted using a phenomenographic approach, which involved transcription of the interviews verbatim and analyzing through a rigorous iterative process (Marton & Booth, 1997), but is not essential. The analysis process began once all interviews were conducted and transcribed. The analysis process of this research was guided by González's (2010) research (see Figure 2). First, all transcripts were read and reread extensively to develop initial ideas regarding the students' understanding of the use of mobile devices in learning context. Second, the initial ideas were highlighted in a separate place based on their similarities and differences. Third, the researchers

then accumulated their initial ideas together and thereafter discerned primary *categories of description* focusing on similarities, dissimilarities, and central meaning of each initial idea. Fourth, the researchers finalized the categories of description following two guiding principles: "(1) the use of no other evidence except the interview transcripts; and (2) the bracketing of the researcher's own conceptions in relation to the phenomenon" (Bowden, 2005, p. 15). Finally, we articulated the final *outcome space* by establishing relationships among the categories that followed a hierarchical relationship.

Rigor, Reliability, and Validity

The iterative and collaborative nature of this research enabled the team to maintain awareness of rigor, validity, and reliability as described by Åkerlind (2012). First, the validity of outcome space was primarily based on presenting the
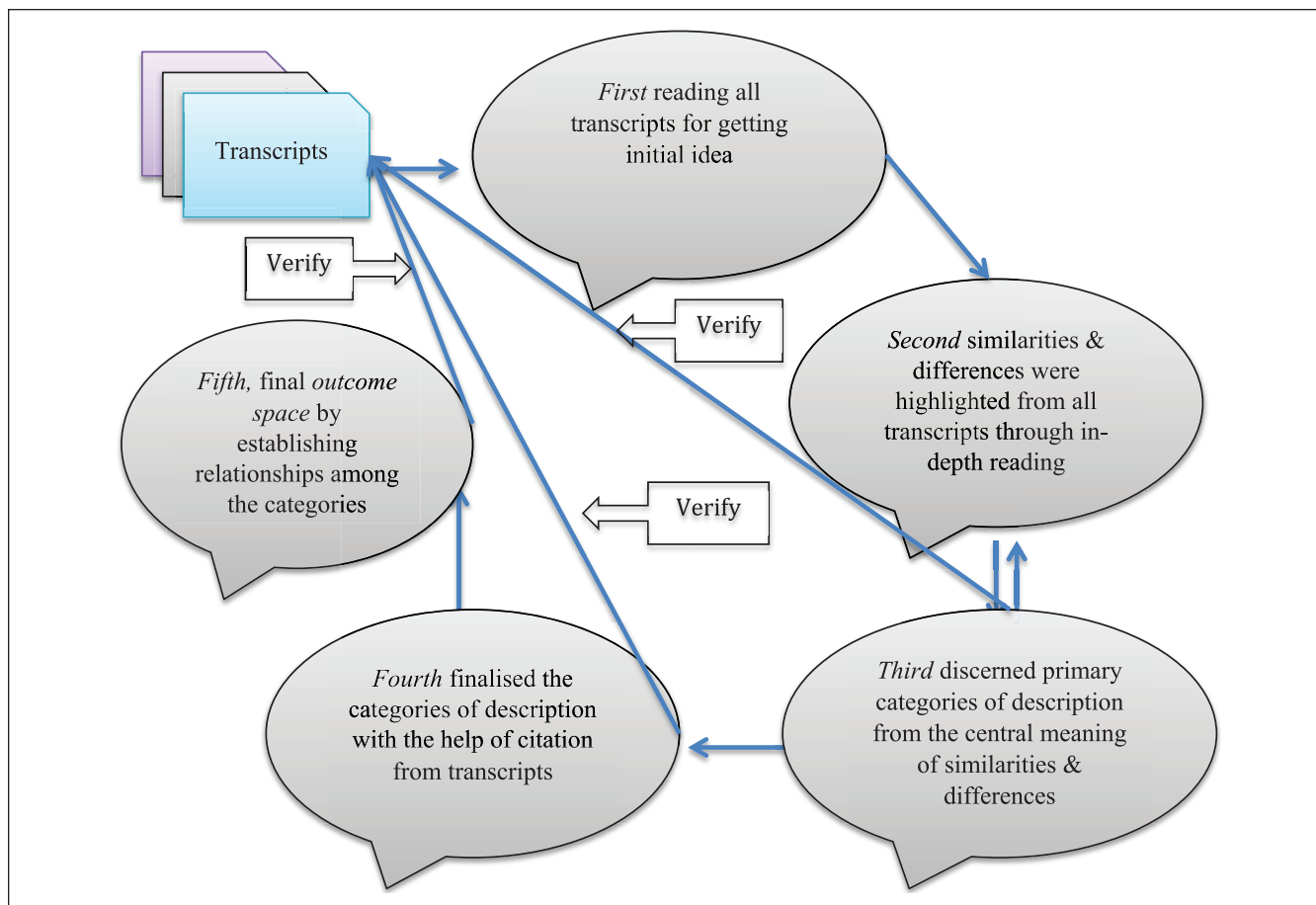
Figure 2. Analysis process of the research—guided by González (2010).

appropriateness of the internal logic of how the categories relate with each other (Marton, 1986). Second, the validity was established by examining the categories in light of how they make sense among related studies (Åkerlind, 2012). Reliability was taken into consideration through the use of appropriate methodological procedures to attain high-quality and consistent data for analysis (Åkerlind, 2012). This involved careful design of interview questions, taking care not to influence or bias the interviewee, adopting the analytical framework of a structure of awareness, controlling, and checking the researchers' interpretations, presenting results in a manner to enable scrutiny and establish interjudge communicability. Care was taken to document each step of the research process in detail. The rigor of the phenomenographic research process can be enhanced by working within a research group (e.g., Bowden, 2005). Here, the group process helped to ensure the completeness of the analysis. Furthermore, it helped minimize each researcher's personal perspective to remain true to the data in formulating the categories of description (Kettunen & Tynjälä, 2018). After preliminary categories were decided, these were discussed and finally agreed on after some negotiations regarding interpretations.

Findings

To answer the research question, first, we present outcomes from the analysis of the students' experiences on mobile devices in their learning in the form of five categories of description. Second, to gain a much deeper insight about the categories of description and the investigated phenomenon, relationships among the categories are presented (see Table 2).

Category A: Medium for Communication

In Category A, m-learning is seen as a tool for communication. As Table 2 indicates, the main focus of using a mobile device in this category is to communicate among students and/or teachers for administrative purposes. For example, if a student is late for a particular class, his or her peers phones or sends a text message to the student reminding him or her to attend the class. Similarly, students can communicate with their teacher directly through their mobile phone to gain a myriad of information, such as a change in class time, the location of extra classes, and the circulated announcement that they missed. Participants' comments described how the

Table 2. Categories of Description and Their Variation.

Categories of description

	Category A	Category B	Category C	Category D	Category E
Key aspects	m-learning is a medium for communication	m-learning is a medium for management of learning materials	m-learning is an effective tool for learning	m-learning is a means for collaborative learning	m-learning is a means for development of new ideas
Main focus	Communicate for administrative purpose	Acquire various learning materials	Consider as an effective tool for learning	Provide a collaborative learning environment	Promote students engagement in myriad tasks to create new ideas
Scope of learning	Scope of learning is limited	Learning occurs while accessing, storing and retrieving learning materials	Same as Category B. In addition learning occurs at anytime and anyplace	Learning is extended to offer students' engagement through collaborative learning	Learning is further extended to offer students' active engagement in critical thinking for developing new ideas
Teacher's role	Communicate with students for administrative purpose	Share learning materials and allow students to record their lectures	Same as Category B. In addition, allow students to take snapshots to save students' time and money	Facilitate students' learning by interacting with them	Offer active learning opportunity
Main learning style	Not clearly seen	Accessing, storing, retrieving	Accessing, storing, retrieving (distinguishing features are flexibility, cost-effectiveness and time saving)	Collaborative	Deep thinking and analyzing learning tasks

mentioned communication and interactions occur through mobile devices:

> So, you may be having classes at this level [of academic building] . . . but at time you go there, you don't find them there then you call them to find where they are [to get the information about the class]. [P5U1]

> So, in WhatsApp, we have one group which we try to communicate every time when someone [in the group] is confused about something [such as] information regarding some classes or quizzes. So, we just try to update each other [through this mobile application]. [We inform that] we have quiz tomorrow, or there is no class or there will be class. [P9U1]

Synchronous communication is seen as the central focus, whereas asynchronous communication is less likely to be seen in this category. It is important to note that this communication is predominantly focused on eliminating students' confusion regarding administrative purpose. For example, participants in this research reported that whenever they have any confusion regarding class schedule, they make direct phone calls to respective teachers so that it can be clarified. In some cases, through direct phone calls, teachers

contact class captains to reschedule classes or to arrange extra classes:

> Sometimes when we come to class and the teachers are not yet there and we see that the time is passing. So we used to give [a phone] call [to] our teachers "Sir, [do you] remember we have class with you, are you coming or not?" [P9U1]

> You should keep your mobile phones on because I'll call . . . to inform you whether this class will be held or not. [P9U1]

In brief, the idea of communication in this category is foregrounded. However, this communication is not seen as enhancing students' learning. Rather, it is used as a medium to announce their class schedule. Therefore, students' learning through mobile devices is seen less focused in this category.

Category B: Management of Learning Materials

In Category B, mobile learning is viewed as tools, equipment, and hardware for management of learning materials. Students in this category are seen using three strategies such as accessing, storing, and retrieving learning material so as to manage

their learning. As Table 2 shows, the main focus is diversifying the use of mobile devices in getting various learning materials from different sources such as class lectures, class notes, and online resources and storing them in these handheld devices for further use. Participants highlighted that with the use of their handheld devices, they can get various learning materials and store them in their mobile so that they can get them whenever they are needed. For instance, if a teacher gives a lecture using PowerPoint presentations, students can easily download those presentations from the sharing device (teacher usually uploads that presentations for the students) using their mobile devices and save it:

> I use it [mobile device] to collect teachers' lectures, collect notes from teachers [P8U3]

> You will get everything like PDF that you can put in your phone, you can even download many books in your phone and pictures also. [P2U1]

In this category, a mobile device is also seen as a recoding tool for future learning. Two models of recording are used. In the case of *audio recordings*, students, while the class is going, press the record button of their mobile device by taking consent from the class teachers and record everything being said during the class so that the teachers' explanations may be used later during their free time to reflect or remind them of the content of the lecture:

> Then well, I recorded numerous lectures and I listen to them now and then when I feel like. [P14U2]

Students, in this category discussed their use of handheld devices to *video record* teachers' instructions during practical classes where teachers manipulate and interact with various equipment, apparatus, and components. For example, during lab classes, students recorded video activities that seem difficult to get through while teachers were explaining and demonstrating them. The main aim of recording the sessions was to retrieve the activities later in their free time to watch again:

> You can record the lectures, you can make videos during the labs and you can practice later. [P2U1]

> Those who cannot get everything they can just record the thing, record the whole lecture and watch it latter. [P15U1]

Mobile devices, in this category, are also seen as a medium through which students take snapshots of important learning materials that are useful for their future learning:

> So after the teacher finishes before he wipes off the board, you just try to capture the images from board so that when you go back, maybe you will try to copy them to your PC or you just try to ok I have this in my phone I'll just read it. [P9U1]

In Category A, mobile learning is further seen as a means to access a wide range of information to clarify and to update knowledge. Students consider mobile devices as a useful tool to gather various learning materials and other worldly news. For example, with search engines such as Google or Yahoo that are accessible from their mobile phones, students can search for the desired academic information easily. This information is later downloaded and stored to their mobile devices:

> . . . so, whenever you need something to know from the outside, you just go to the internet and pick [access] the knowledge from there. [P15U1]

> I installed a dictionary application. In case I get a word that I don't understand, I use the dictionary on my mobile phone, then I can know the meaning of that word. [P1U1]

Category B differs from Category A, as it not only relies on communication for administrative purposes but also emphasizes real learning through managing of *learning materials using their* mobile devices.

Category C: Effective Tool for Learning

In Category C, m-learning is viewed as an effective tool for learning. This perceived effectiveness is understood through numerous factors such as time-saving, cost-effectiveness, mobility, and flexibility in students' learning. Thus, usefulness of using mobile devices is at the forefront (main focus) of students' awareness (Table 2). Students perceived the use of mobile devices as a means of accessing their learning materials which, in the long run, enabled them to enhance their learning habits within the shortest period of time:

> If I just take a snap, it will take like a second but if my colleague decides to draw it in his book, it will take him like 20 minutes. So in such a way, it saves time to me. [P3U1]

> It [mobile device] is easy to carry and it saves our time. [P10U2]

The use of mobile devices in this category is also viewed to be cost-effective. University students can access massive learning materials by spending less amount of money. Without their mobile device, it would be very expensive for them to access these learning materials. Comments describe how m-learning supports these activities:

> Then another thing [is that], it saves money. In which way? For example, if a teacher gives us a slide which has like 56 pages, it means if I print it will be costly. But if I just copy the slide to my phone, I think in that way, it saves me some TAKA [Bangladeshi currency]. [P3U1]

> It saves me money. For example, in library, if you want to get a question paper you need to photocopy but here, I just take snapshot, It's easy to use just one click. [P12U1]

University students in this category view the objective of using mobile devices to support their learning on an "any time any place" basis. In this case, m-learning provides a platform on which students can access their learning materials whenever they feel comfortable and ready to learn. For example, the participants stated that in most cases, they could go anywhere with their devices and could utilize it either to revise their class notes that were saved or to access relevant information to support their learning. They also expressed that they can transfer their learning materials from their desktop computers to their mobile devices to make them available at "any time any place." This learning style is important for students who prefer a quiet learning environment where they can sit peacefully and do their learning:

It always depends [how do we use it] but the major point is that it's mobile and its mobility aspect. It's like wherever I go I have my mobile phone. . . [P3U1]

Mobile learning, I understand it by using some devices which you hold in your hands and can have access to it anywhere and anytime for your use in learning. [P1U1]

For example, if I'm in the bus or I'm going somewhere, I can use my handheld device and take look on my notes or I can use it to communicate with my universities. [P12U1]

In Category C, similar to Categories A and B, university students perceive that the use of mobile devices helps them to communicate for administrative purposes and to access, store and retrieve necessary information to ease their learning. However, Category C differs from Categories A and B as it focuses not only on communication and management of learning materials but also works as a time-saving, cost-effective, and portable device for enhancing student learning. Learning in this category is extended to at "any time and any place," whereas this learning is not linked with deeper level of activities.

Category D: Means for Collaborative Learning

As Table 2 shows, Category D focuses on the creation of a collaborative learning environment—a space for engaging students in their learning through collaborative activities. m-learning, in this category, is perceived as a medium through which students can develop their own understanding. One of the roles of using mobile devices in students' learning is to offer direct (synchronous) and indirect (asynchronous) interactions among student–student and/or student–teacher. Students, in some cases, are seen to use different social media such as Facebook, LinkedIn, and WhatsApp for the stated collaboration using their mobile devices. First, *student–teacher interaction*: participants, in this research, stated that they use Facebook, email to interact with their teachers and/or supervisors at the time when they get confused or they face any difficulties in completing their assignments, projects, or

thesis in due time. Thereafter, students, using their mobile devices, receive feedback from their respective teachers clarifying what they wanted to elucidate. This process enabled them to carry on with their learning even when they were away from regular classroom:

When our teacher was not in the campus, even he was not in Bangladesh. He gave us his Skype [ID] and I used [gave a call] one time to ask him one question . . . [when] I got some difficulties. So I sent a message to the teacher through Skype. He answered me [through Skype] and [then] I got the solution. [P2U1]

I can easily consult [with] the teacher through the email [of my mobile phone] for more clarification. [P1U1]

Second, *student–student interaction*, in this category, is also seen while students work in a group. Students generally use their mobile devices to get in touch with their colleagues (peer groups) to complete their group works such as assignments, solving problems, or group discussion. For example, whenever participated students got stuck or confused during their learning, they usually contacted their classmates asking for help to clarify certain concepts. Their colleagues provided immediate responses that enabled them to have a better idea of the topic than before:

I can always use the phone and I can get in touch with them [peers] and I can always use their ideas to incorporate into my own learning. [P16U4]

Even I can use social sites for group chats to learn things, which I cannot understand from my teachers. My friends can share or explain it to me or [likewise] I can teach my friends in a group chat [P7U2]

But remember you have to work on the assignment in time. . . . first of all we can divide the assignment [among our group]. So I do my part, and go to Facebook to send him [group member] what I have done, when he is at home. When he reads through [my part] he also sends me his [part]. [P3U1]

In Category D, the focus is shifted from communicating for administrative purpose, gaining information, involving individual learning in Categories A, B, and C, to students' engagement through collaborative learning to develop their understanding. Therefore, the learning process using mobile devices, in this category, is more focused on learners' understanding where students are responsible to create a collaborative learning space.

Category E: Means for the Development of New Ideas

In Category E, m-learning is seen as a means through which students engage in a myriad of tasks involving deep analysis,

Table 3. Referential and Structural Components of Categories of Description.

| Referential ("what" of m-learning)	Structural ("how" of m-learning)		
	Fragmented	Cohesive	Complexity
Medium for communication	A		Simple, lowest, least developed (learning is rarely situated)
As in (A) and managing learning materials	B		Complexity is higher than before; Under developed
As in (B) and an effective tool for learning	C		Complexity is higher than before; Developed
As in (C) and collaborative learning		D	Complexity and Development is higher than before
As in (D) and developing new ideas		E	Most Complex, Highest developed
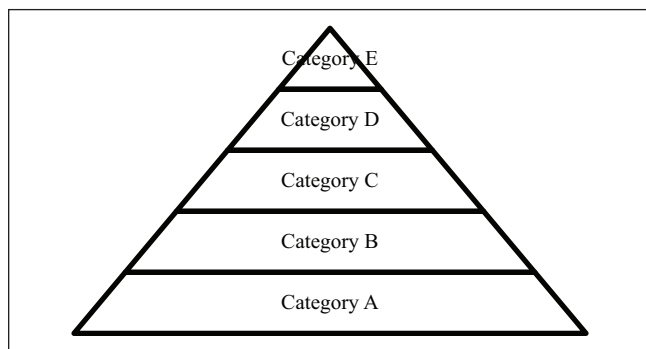
Figure 3. Hierarchical relationships among the categories (complexity increases upward).

critical thinking, and interpretation of various aspects of their learning (Table 2). University students, in this category, have the opportunity to research deeply and analyze carefully about a certain topic using their mobile devices. These activities assist them in expanding their existing knowledge that enables students to have various views of the same topic that they may not have before. For example, participants stated that students, in many cases, are assigned different analytical learning activities that require deep understanding and rigorous analysis to come up with best possible solution. In this context, m-learning provides them the right platform to perform that. They can easily access various information and resources related to their topics that provided them different ideas to assist in building their conceptual understanding facilitating to analyze their work critically and deeply. These learning activities promote new ideas that later collectively construct innovative and advanced knowledge related to that particular topic, which was not previously seen among them. Following are some of the excerpts that reflect students' engagement in this category:

> I mostly use it [mobile devices] for analysis. Like, we have to do a lot of literature analysis and it is not like a given fact. Like, you don't just study, you form your own idea around it. So, to do

that, you need to be involved with it as much as possible. . . So the more I read it, the more ideas I get about it. So, it [mobile devices] helps me analyse more. It [this analysis] gives me the idea that I didn't think of before. [P16U4]

> Whenever you are, you know, communicating with friends, whenever you chat with friends, [during this time] different kinds of aspects are coming out. So in that case, the inner ideas of creativity are enriched. So, in that case, our literature term is known as ideas. So these ideas always get fractured, rendered and then joined up together and that's why when they are joined up together, they will become a good new thing. It's something different, you know, and you will feel like you have created something. [P4U2]

Category E includes, modifies, and extends the elements of Categories A, B, C, and D. As in Category D, interaction and collaboration is an important feature, but there is a major emphasis on students' active engagement in critical thinking for the purpose of developing new ideas and offering creativity in their learning.

Hierarchical Relationship Among the Categories of Description

Categories of description in phenomenographic studies are expected to have logical relationships to one another (Marton & Booth, 1997). These relationships are posited to constitute a structural hierarchy of inclusiveness, in terms of the increasing complexity (less to more complex) from the lowest to the highest category of description (Åkerlind, 2005). Considering this view, the relationships among the five categories were established based on the central aspects in Table 2 that made each category identical and distinct, and the referential ("what" of m-learning) and structural ("how" of m-learning) components of using mobile devices in student learning (see Table 3 and Figure 3).

Students in this research held a range of views about m-learning in higher education. These views were translated into five categories that formed a hierarchical relationship.

More elaborately, the highest order category is the most complete in nature, that is, it includes elements from the other four lower order categories. For example, the fifth category (Category E) is hierarchically above the former four categories (Categories A, B, C, and D). It was found that m-learning in this category is viewed not only as a medium for communication, managing learning materials, a tool for effective learning, and collaboration but also as a means of providing immense involvement in critical thinking for developing new ideas.

Furthermore, Category E (compared with other categories) presents more sophisticated aspects such as it is the most complex in nature (includes students' understanding of m-learning), and students achieve the highest level of development. A similar nature is found in Category D. Therefore, Category D contains elements from lower order categories (Categories A, B, and C), but it may not include facets from the higher order Category E.

In this way, Category A is the lowest order, that is, it does not include components from Categories B, C, D, and E. In addition, Category A represents less complexity than the other four categories (Categories B, C, D, and E). For instance, Category A, as stated earlier, views m-learning as a means for communication among students and teachers where learning rarely occurs. These aspects of hierarchy are shown in Figure 3 and Table 3.

The logical relationship among these categories expands further based on a framework linking referential and structural aspects of using mobile devices in student learning. The framework can be seen in Table 3. This research discerned two broader structural components that are linked with referential components. They are fragmented components (Categories A, B, and C) and cohesive components (Categories D and E). Fragmented components deal with accumulation and reproduction of knowledge, whereas cohesive components include elements of restructuring of existing knowledge and creating new knowledge for conceptual development (Ellis, Goodyear, Calvo, & Prosser, 2008). The first three Categories, A, B and C are considered fragmented components because the main focus of using mobile devices is on managing learning materials, whereas students' development (by active involvement) is given little attention. It can be seen that there is either no learning (Category A) taking place or simple forms of learning (Categories A and B) that do not require any kind of deep analysis but accessing, storing, and retrieving knowledge for their convenience. In contrast, the last two categories (D and E) are cohesive as they involve deep analysis and critical thinking and are more complete (compared with the first three categories). The main focus of Categories D and E is students' development through active learning such as group discussions, collaboration with peers and teachers, and deep thinking linked to diverse knowledge to create new understanding. However, each category signifies a distinct way of viewing the investigated phenomenon that clearly makes each category qualitatively different than others.

Discussion

This research identified students' conceptions of mobile devices in their learning within the context of Bangladeshi universities, establishing five distinct categories of description; mobile learning is a medium for communication, medium for management of learning materials, a tool for effective learning, means for collaborative learning, and means for the development of new ideas. Four dimensions of variation were revealed: main focus, scope of learning, teachers' role, and main learning style. The five categories arranged hierarchically ranging from the lower level to the higher level of understanding are classified into two broad conceptions similar to previous phenomenographic studies (Ellis & Calvo, 2004; Ellis et al., 2008; Ellis, Goodyear, Prosser, & O'Hara, 2006; Yang & Tsai, 2010).

Students' conceptions of mobile learning are an emerging concept of investigation in educational research. Therefore, the findings of this research are limited in scope as are previous phenomenographic studies. However, the findings may be interpreted in wider contexts, including beyond phenomenographic studies. In Category A, mobile devices could be used for communication purposes, which is in line with results from other studies (e.g., Churchill et al., 2016; Churchill & Wang, 2014; Oyelere et al., 2018). However, communication through mobile devices in Category A is limited to circulating administrative information that has no direct relation to enhancing student learning. However, few studies described extended communication that is linked with the quality of students' learning. For instance, Hayes and Weibelzahl (2016) reported that communication outside of normal class time between teachers and students has a significant impact on student learning. Other categories (Categories C, D, and E), in contrast to Category A, perceived mobile learning as a way of enhancing student learning. More elaborately, Category C provides evidence of accessing student learning materials remotely and easily; Category D stipulates students' collaboration with peers and teachers; and Category E provides students' involvement in critical analysis, that all activities provide different ways of enhancing student learning. Therefore, this research is one of the pioneer research initiatives in phenomenographic studies and provides new insights (five qualitative different ways of conceptualizing m-learning) in higher education of Bangladesh.

The findings of this research further support the recent studies conducted focusing on m-learning in different contexts. For example, Category C provides evidence for using mobile devices for flexible learning (Cochrane & Narayan, 2016). Category D supports collaborative learning (Fu & Hwang, 2018), and Category E provides a space for critical thinking (Heflin et al., 2017; C. L. Lai & Hwang, 2014). However, although the findings of this research confirm the general aspects of prior studies, this research also reveals distinct aspects that provide a much deeper understanding of

using mobile devices in student learning in higher education. More specifically, Category B provides evidence for managing learning materials using three distinct strategies (access, store, and retrieve), Category C indicates that students perceive effectiveness of using mobile devices through four separate factors (time, cost, mobility, and flexibility), and Category E provides empirical evidence of creation of new knowledge that is rarely found in prior studies. Moreover, Categories D and E reflect the epistemological belief that knowledge is constructed and/or co-constructed by students. That is, through this process, students are engaged with different activities using their mobile devices such as interacting (synchronous and asynchronous) with teachers and peers, which facilitates the development of immense understanding, solving problems, clarifying ideas, creativity, and deep thinking.

Earlier research on the adoption of mobile devices generally identified findings linked with usefulness of incorporating mobile devices in education, challenges of including m-learning in developing countries (e.g., Bartholomew & Reeve, 2018; Crompton, Burke, & Gregory, 2017). Hsieh and Tsai (2017) in phenomenographic research similarly reporting that prior literature in mobile learning generally focuses more on effectiveness of mobile learning and mobile learning system design. Furthermore, findings of prior studies, similar to this research, provided evidence of students' engagement through mobile devices that promote students core competencies, such as collaboration, problem-solving, and critical thinking (Fu & Hwang, 2018; Heflin et al., 2017; C. L. Lai & Hwang, 2014). However, most of these studies paid little attention to qualitatively different ways university students could use mobile devices in their learning. Therefore, this research provides empirical evidence that shows five different views of using mobile devices that are hierarchically arranged.

Implications

The findings of this research provide insights into and information about the practices associated with mobile learning in a Bangladeshi university context. The research has implications for research, teaching, and learning in technology-mediated higher education worldwide and offers a basis for continuing with mobile learning development and research in Bangladesh and other similar contexts. As growing interest in m-learning in the teaching and learning practice increases, particularly in developing countries, students' experiences with m-learning in higher education is becoming an important focus of research initiatives (Kafyulilo, 2014; Pimmer et al., 2016). By exploring the logical relationships between qualitatively different conceptions, this research highlighted the important factors that affect mobile learning in a university context and therefore the results can facilitate the planning, implementation, and evaluation of mobile learning. The findings of this research could be used to inform these initiatives, as this is one of the very first studies to investigate m-learning following a phenomenographic research approach.

In relation to practices, these findings support different ways of using mobile devices in student learning, which is a potential input for improving teaching and learning practices (Prosser & Trigwell, 1999). For example, it may help teachers to develop different pedagogical approaches to student learning styles in relation to incorporating mobile devices, which guide university students toward maximizing the use of mobile devices in their learning. Higher education students could become comfortable with less complex categories (such as Categories A, B, and C) before they are able to engage in more complex Categories (such as Categories D and E). So, pedagogically, it would be wise to scaffold student learning to enable them to engage gradually from less complex orientations to more complex experiences via the use of mobile devices. The findings of this research could play a crucial role in informing students how they can use their mobile devices for learning purposes. In addition, policy makers and curriculum developers are provided with empirical evidence in relation to different ways students use mobile devices that can facilitate the formulation of new policies regarding using mobile devices in and beyond the classroom to enhance student learning experiences.

Limitation and Conclusion

Before concluding, it is important to acknowledge the limitations of this research. First, the number of participants in this research was relatively small. They were recruited from four universities in Bangladesh. The hope was for more female participants and more cross-disciplinary participation. It is possible that with participants from a wider representation of different disciplines, other critical aspects may well have emerged. However, a sample of 16 is reasonable number in the phenomenographic research approach (e.g., Forster, 2013; González, 2009). For instance, Forster (2013) interviewed three professionals from the nursing practice about their conceptions of information literacy. Second, this research relied mainly on student interview data without considering other data sources. However, a significant amount of high-quality phenomenographic research conducted in the prior literature has been based on only interview data (e.g., Åkerlind, 2004; Khan, Bibi, & Hasan, 2016; Khan & Markauskaite, 2017; Limbu & Markauskaite, 2015; Prosser & Trigwell, 1999; Säljö, 1979). Finally, the findings of this research depend on the context (higher education of Bangladesh), which is in line with the phenomenographic research approach. Kettunen and Tynjälä (2018) reported that "qualitative studies' findings are unique in their respective contexts; nonetheless, transferability to other settings and groups may be possible" (p. 7). Therefore, the students' conceptions of mobile learning, which were discerned in this research, may be useful for similar contexts in other

countries in a global perspective. However, the aim of phenomenographic research approach is not to provide generalizable results, rather its focus is on a particular phenomenon that needs to be investigated deeply.

Therefore, university students may use mobile devices in five qualitatively different ways in their learning: *a medium for communication, medium for management of learning materials, a tool for effective learning, means for collaborative learning*, and *means for the development of new ideas*. In addition, four dimensions of variation were revealed that make the categories of description inclusive. This research demonstrates that students in higher education have diverse preferences of using mobile devices in their learning that involve both fragmented and cohesive facets of learning. The findings of this research report against the findings that using mobile devices in classroom context can be distracting (Balakrishnan & Gan, 2016; Bartholomew & Reeve, 2018). There may be two possible reasons for identifying these: first, the purpose of this research was to identify qualitatively different ways of using mobile devices in higher education. Therefore, identifying the negative use of mobile phones was not the main focus of this research. Second, the participants were recruited purposively who had experience using mobile devices in their learning; therefore, their perceived views of using mobile phones were identified collectively.

While incorporating new technologies, in this case, mobile devices into learning contexts at university education, fresh opportunities were used to renew and refresh teachers' pedagogical approaches to ensure effective student learning (Ellis et al., 2006). Therefore, further research from a teaching perspective in relation to using mobile devices in higher education is required to investigate both developed and less developed countries. The main aim of conducting such future research is to establish the relationships between students' conceptions of m-learning and teachers' conceptions of m-learning that may link with student learning outcomes. Previous studies, in this point, have provided evidence that students' conceptions of learning are interconnected with teachers' conceptions of teaching, which are further linked with student learning outcomes (Prosser & Trigwell, 1999). Therefore, students' conceptions of m-learning provide a basis for enhancing teaching and learning through mobile devices in higher education. This research offers teachers an understanding of different ways of using mobile devices in students learning in higher education. The findings of this research extend the previous literature from *mobile learning effectiveness* (Andujar, 2016) and *system design* (Chen, Liu, & Hwang, 2016) to *how mobile learning is experienced by the students*.

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